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On a photograph taken by Max Wolf, 1891, the estimated magnitude is 11·3, and on two photographs taken with the 8-in., mentioned under No. 4, the magnitudes are 12·5 and 12·2.

(8) RR. *Cygni*, 20^{h} 42^{m}·6, Decl. + 44°30′ (1900). As the spectrum of this star remains in doubt, it was examined on the nights of August 8, September 9, and was found to be III.!! The bands are large and ill-defined, but the character of the spectrum is undoubted.

(9) *Es. Birm* 706, R.A. 21^{h} 23^{m}·3, Decl. 62° 8′·4 (1900). This is D.M. + 61°·2134. In consequence of there being some uncertainty about the type, it was examined 1893 September 30, and found to be type III.!!

(10) D.M. + 60°·2432, 22^{h} 40^{m}·4, Decl. 61°12′ (1900), mag. 8·9. This star was encountered in sweeping 1893 October 8, and found to have a spectrum of type IV.

(11) *Es. Birm* 735, R.A. 22^{h} 43^{m}·7, Decl. + 54° 38′ (1900), mag. 9·5, D.M. + 58°·2863. On 1893 October 8 I examined this star, and found it had hitherto been wrongly identified as D.M. + 58°·2865. The spectrum is not IV. but III.!! My observations of its magnitude are:—

1887.	Mag.	1893.	Mag.
Oct. 20	8·5	Oct. 8	8·5
Dec. 4	8·2	11	8·3
Dec. 7	8·5	16	8·3
		Dec. 1	8·3

My observations are therefore very accordant, but still, the great difference between them and the D.M. magnitude suggests variation.

(12) *Es.* 141, R.A. 23^{h} 22^{m}·2, Decl. + 48°58′ (1900), mag. 9·3. This is D.M. + 48°·4051. The spectrum was observed for the first time on 1893 December 1, and found to be type IV., the three normal zones being well seen.

On the Orbit of α Centauri. By T. J. J. See, A.M., Ph.D. (Berlin).

(*Communicated by S. W. Burnham.*)

The orbit of *α Centauri* has been investigated so frequently in the last quarter of a century that the elements of this famous southern binary ought now to be well determined. But owing to the discordance of the older observations, even the recent orbits of Elkin [*] and Powell [†] give periodic times differing by

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[*] *Inaug.-Dis., Ueber die Par. von α Cent.*, p. 8.

[†] *M. N.* vol. xlv. p. 19.

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more than ten years, while the other elements are of necessity correspondingly uncertain. Downing* considers the orbit of Elkin (with a periodic time of 77 years) essentially correct, and vigorously contests the claims of Powell, who insists upon a period of 88 years, which in turn is supported by the researches of Doberck.

The great interest attaching to *α Centauri* as the first revolving double star ever discovered, the one binary system where the components are of the first and second magnitudes, and at the same time the nearest of all the fixed stars, renders the investigation of its orbit of such profound interest, as to justify research that will materially advance our knowledge of this celebrated system. After all that has been done on the orbit of this star, there is evidently no hope of obtaining results of real value without making the investigation as thorough as the material at present available will permit.

In beginning this research it was therefore decided to collect all the measures from original sources, with the number of nights on which the measures were taken, and the number of observations entering into each mean result. In some cases, unfortunately, these data had not been recorded by the observers, and hence could not be obtained; while in a very few cases the observations had to be taken on the authority of other astronomers who have published lists of observations.

The material obtained, however, certainly includes everything of any value hitherto published, and is ample for the deduction of an orbit substantially correct.

The first observations of conspicuous worth are the micrometrical measures of Sir John Herschel, made during his residence at the Cape of Good Hope. The measures of Herschel taken in conjunction with measures recently made expressly for the purpose, have enabled us to determine the orbit of *α Centauri* with a degree of precision which is remarkable, when we consider the character of the observations. It will be found on inspecting the list of measures, that many of them are materially vitiated by errors of observation, some systematic, some accidental. In judging of the value of results, however, we must remember that *α Centauri* is a very bright star, so that the images are unusually large, and hence, unless the telescope is practically perfect and the atmospheric conditions are entirely satisfactory, it is hardly to be expected that the measures will be very accordant. We must also remember that there are no specialists in double-star work in the southern hemisphere, and hence we must not expect results such as could be obtained by the skill of a Burnham or a Struve. Of all the orbits hitherto found for *α Centauri*, only a few have now anything more than historical interest; some of the more recent elements are given in the following table.

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* *M. N.* vol. xlv. p. 151.

Table of Elements of α Centauri.

P.	T.	e.	a.	☊	λ.	i.	Authority.	Source.
			″	°	°	°		
79	1863·25	0·818	...	...	32·7	...	Jacob	*Ast. Nach.* Bd. xliv. p. 43.
82 59	1857 01	0·96	31·76	2·6	27·65	77·3	Powell	Mem. R. A. S. vol. xxiv. p. 93.
75·3	1858·01	0·966	30·0	177·83	27·4	77·83	Powell	,, ,, ,,
85·042	1874·85	0·667	21·80	21·6	59·53	82·3	Hind	*M. N.* vol. xxxvii. p. 97.
77·42	1875·97	0·526	17·50	25·8	54 8	79·52	Elkin	Dissertation, p. 8.
88·536	1875·12	0·533	18 45	25·54	45·97	79·4	Doberck	
76·222	1875·95	0·516	17·33	25·51	54·99	79·25	Downing	*M. N.* vol. xliv. p. 239.
87·438	1875·45	0·5443	18·89	25·83	48·98	79·78	Powell	*M. N.* vol. xlvi. p. 337.
80·34	1875·74	0·526	17·20	25·22	52·5	79·53	Gill	Mem. R. A. S. vol. xlviii. p. 15.

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In the following list will be found all the measures of *α Centauri* which are of any value, with the number of nights (*n*) on which the measures were made. The observations of T. Maclear, G. Maclear, and W. Mann, which were made about the middle of this century, are here taken from Dr. Elkin's *Inaugural Dissertation*, in which they were first printed; the number of nights on which these measures were made were kindly supplied by Dr. Elkin in a private letter. Most of the other measures are taken from the *Memoirs* and *Monthly Notices* of the Royal Astronomical Society.*

The writer desires to acknowledge his special obligations to Messrs. Tebbutt, Pickering, Douglass, Russell, Sellors, Gill, and Finlay for securing sets of measures of *α Centauri* expressly for the present research; also to thank Herr Hans Ludendorff, of the Royal Observatory, Berlin, for carefully confirming from the original sources the measures of Lacaille, Brisbane, Dunlop, and Johnson.

Observations of α Centauri.

t	δ	ρ	n	Observer.
	°	″		
1690·0	...	...	1	Richaud
1709·5	...	...	1	Feuillée
1752·20	218·73	20·51	...	Lacaille
1761·5	...	15·6	1	Maskelyne
1822·00	209·6	28·75	...	Fallows †
1824·00	215·41	22·45	35 +	Brisbane
1826·01	213·18	22·45	...	Dunlop
1830·01	215·03	19·95	...	Johnson
1831·00	215·97	22·56	...	Taylor †
1832·16	216·35	19·85	...	Johnson & Taylor ‡
1833·0	217·45	18·67	7 ±	Henderson
1834·33	217·33	17·83	1	Herschel §
1834·45	218·78	17·50	2	Herschel
1835·08	218·80	17·33	1	Herschel
1835·89	219·59	17·02	11 − 1	Herschel
1836·61	220·26	16·76	1	Herschel
1837·22	220·65	16·39	4	Herschel

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* The writer intended to have given in this paper the original source of each measure and the number of observations on which it is founded; but, as these data render the paper voluminous and are not essential to our present purpose, they are reserved for a future publication.

† Taken on the authority of Herschel.

‡ See Powell, *Monthly Notices*, 1855–56, p. 171.

§ Herschel's means have been formed anew.

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t	δ	ρ	*n*	Observer.
	°	″		
1840·00	223·2	14·74	...	Maclear
1846·21	232·4	10·96	3	Jacob
1846·80	234·3	9·56	4	Jacob
1847·09	235·7	9·33	2−3	Jacob
1847·36	234·5	9·31	3	Jacob
1848·00	237·93	8·05	13−12	Jacob
1849·63	244·5	6·23	...	Jacob
1849·94	245·25	6·96	1	Maclear
1849·97	245·42	7·04	3−2	Maclear
1850·10	246·63	7·01	1	Maclear
1850·17	245·75	7·08	6	Maclear
1850·20	245·85	6·84	3	Maclear
1850·31	247·07	6·75	4	Maclear
1850·37	247·52	6·52	7	Jacob
1850·38	245·74	7·12	1	Maclear
1850·41	242·0	7·78	15	Gilliss
1850·61	248·84	6·58	3	Maclear
1850·64	249·1	6·20	7	Jacob
1850·92	250·27	5·88	6	Jacob
1850·94	251·84	6·02	3	Maclear
1851·02	251·05	5·88	8	Jacob
1851·08	252·50	6·12	3	Maclear
1851·20	252·13	5·94	10−8	Jacob
1851·33	253·92	6·02	5	Maclear
1851·56	254·42	5·88	3	Maclear
1851·70	256·38	5·27	8	Jacob
1851·94	256·58	5·80	3	Maclear
1851·94	258·2	5·11	9−8	Jacob
1851·99	258·85	5·08	8−7	Jacob
1852·25	259·02	5·72	3	Maclear
1852·27	261·07	5·03	7	Jacob
1852·38	261·88	4·94	6	Jacob
1852·43	261·67	5·27	5	Maclear
1852·53	264·16	5·00	4	Jacob
1852·56	262·8	5·03	...	Maclear
1852·58	262·89	5·18	7−9	Maclear
1852·73	262·45	4·95	5−2	Maclear
1852·79	263·31	...	4	Maclear

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t	δ	*p*	*n*	Observer.
	°	″		
1853·05	267·67	4·55	...	Jacob
1853·13	266·54	4·84	4–6	Maclear
1853·15	268·33	4·59	...	Jacob
1853·34	268·72	4·87	5	Maclear
1853·50	271·03	4·68	6	Maclear
1853·58	272·17	4·57	2–1	Mann
1853·58	270·10	...	...	Powell
1853·92	275·19	4·44	4–3	Maclear
1854·00	276·63	4·21	...	Jacob
1854·03	276·85	...	7	Powell
1854·24	278·98	4·62	4	Maclear
1854·25	279·06	4·16	2	Jacob
1854·26	279·62	...	4	Powell
1854·63	283·44	...	3	Powell
1854·66	282·81	4·43	5	Maclear
1854·93	285·88	3·96	5–4	Maclear
1854·96	288·02	...	2	Powell
1855·06	289·32	...	10	Powell
1855·23	290·19	4·38	3	Maclear
1855·29	292·60	...	5	Powell
1855·33	293·8	4·11	10	Powell
1855·36	291·96	4·38	4	Maclear
1855·54	294·73	...	5	Powell
1856·02	301·02	3·99	11–6	Powell
1856·02	302·13	3·85	7–6	Maclear
1856·10	303·06	3·88	18	Jacob
1856·38	306·92	4·05	1	Maclear
1856·51	309·84	3·93	10–9	Jacob
1856·91	311·26	4·21	4	Mann
1856·94	311·88	...	11	G. Maclear
1856·95	310·78	4·05	6	Mann
1856·96	315·77	3·96	10–9	Jacob
1857·15	318·19	4·02	15	Jacob
1857·39	320·60	4·47	2–1	Maclear
1857·86	326·48	4·14	14	Jacob
1858·17	330·51	4·39	5	Jacob
1858·23	339·42	5·09	3	Maclear
1859·34	339·71	5·18	15–12	Powell

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t	δ	ρ	n	Observer.
	°	″		
1859·43	343·44	5·10	5	Mann
1859·52	341·8	4·92	4	Powell
1859·97	346·08	5·00	3	Mann
1860·05	346·55	...	1	G. Maclear
1860·09	345·4	5·65	17−13	Powell
1860·18	349·34	5·52	4−1	Maclear
1860·35	348·87	...	3	Maclear
1860·48	348·7	5·68	1	Powell
1861·05	351·08	6·07	10−9	Powell
1861·09	353·65	6·09	3	Maclear
1861·31	353·03	6·21	7	Powell
1861·58	354·26	6·32	5−3	Powell
1862·0	0·0	10·0	...	Ellery*
1862·20	357·84	6·80	7	Powell
1862·47	0·0	...	...	Ellery†
1862·56	1·38	7·55	3	Maclear
1863·03	1·4	7·2	6−4	Powell
1863·75	5·2	8·5	...	Ellery
1864·11	5·7	7·85	7−5	Powell
1864·72	...	8·1	...	Ellery
1865·56	17·3	9·95	1	Ellery†
1866·06	11·1	9·3	3	Powell
1868·17	...	9·2	...	Ellery
1868·18	...	9·6	...	Ellery
1868·38	13·59	10·29	2	Mann
1868·51	21·8	11·02	5	Ellery†
1869·13	17·97	10·4	2	Powell
1870·1	20·45	10·24	13−12	Powell
1870·61	21·8	10·09	5-4	Powell
1870·65	...	10·2	...	Ellery
1870·65	24·7	10·45	3	Ellery†
1870·75	22·53	10·46	4	Russell
1871·05	23·01	9·89	11	Powell
1871·31	23·7	9·8	7	Powell
1871·48	22·91	10·22	2	Russell
1871·51	24·2	9·41	1	Ellery

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* Apparently a rough "guess."

† From transit observations.

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t	*δ*	*ρ*	*n*	Observer.
	°	″		
1872·47	25·31	9·73	2	Russell
1872·55	24·1	10·36	1	Ellery
1873·16	...	8·3	...	Ellery
1873·33	28·1	9·50	1	Russell
1874·15	30·5	8·0	...	Ellery
1874·47	30·0	7·97	2	Russell
1874·85	34·17	...	...	Lindsay
1875·02	34·21	6·82	...	Seeliger
1875·94	39·3	6·68	1	Ellery *
1876·41	46·97	4·35	2	Russell
1876·61	51·05	4·15	2	Ellery
1876·90	64·3	4·94	1	Ellery
1876·94	51·2	4·5	1	Ellery
1877·14	64·4	3·30	...	Maxwell Hall
1877·25	69·1	3·13	5	Ellery
1877·52	72·77	2·60	2 – 1	Russell
1877·56	77·25	2·11	3	Russell
1877·57	80·50	2·13	2 – 3	Gill
1877·59	81·74	1·90	3	Russell
1877·63	81·49	1·94	3 – 1	Gill
1877·82	97·12	1·85	2 – 3	Gill
1877·89	101·12	1·62	2	Gill
1878·16	116·98	1·77	1	Russell
1878·22	119·82	1·95	3	Russell
1878·28	127·37	1·77	1	Russell
1878·38	139·10	2·40	...	Maxwell Hall
1879·25	174·40	3·41	...	Ellery
1879·47	173·55	3·41	2	Hargrave
1880·18	183·9	5·22	4	Tebbutt
1880·39	185·2	5·56	3	Tebbutt
1880·45	184·98	5·52	1	Russell
1881·28	189·88	5·07	1	Hargrave
1881·54	190·13	7·52	1	Hargrave
1881·65	193·15	7·94	2	Tebbutt
1882·00	194·44	8·23	18	Gill
1882·22	194·6	8·70	1	Tebbutt
1882·50	195·82	9·12	52	Elkin
1884·19	199·0	11·96	...	Russell

* From transit observations.

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t	δ	ρ	n	Observer.
	°	″		
1884·43	199·5	12·32	...	Russell*
1884·53	199·80	12·93	6	Tebbutt
1885·56	200·8	14·05	4–3	Tebbutt
1886·27	202·5	14·89	5	Pollock
1886·38	200·4	14·74	1	Russell
1886·52	201·2	15·19	1	Russell
1886·55	201·02	14·87	4	Pollock*
1886·56	202·42	15·13	10	Pollock
1886·58	201·7	15·18	3	Russell
1886·60	201·41	15·16	4	Tebbutt
1887·39	202·3	16·06	3–5	Tebbutt
1887·43	202·08	15·83	6–5	Pollock
1887·60	202·35	16·28	3–2	Tebbutt
1887·72	202·16	16·18	2	Tebbutt
1887·74	203·0	15·73	4	Pollock
1888·30	203·4	16·87	3	Tebbutt
1888·63	202·93	17·12	1	Tebbutt
1889·45	204·5	17·91	3	Pollock
1890·41	205·2	18·58	2	Tebbutt
1890·47	204·75	18·66	4–3	Sellors
1890·60	205·05	19·06	3–2	Sellors
1890·74	204·6	18·69	1–3	Tebbutt
1891·43	205·62	19·15	5–4	Sellors
1891·56	207·17	19·25	4–2	Tebbutt
1891·57	205·3	19·24	2	Sellors
1891·64	206·4	19·35	3–6	Tebbutt
1892·30	206·45	19·52	2	Gill & Finlay †
1892·40	205·46	19·73	5–4	Sellors
1892·45	205·53	19·75	7–4	Tebbutt
1892·58	205·83	19·73	8–5	Tebbutt
1892·76	206·9	19·96	1	W. H. Pickering †
1893·21	206·9	20·04	1	A. E. Douglass
1893·21	206·75	20·22	2–1	W. H. Pickering
1893·34	206·4	19·92	8	Sellors
1893·42	206·73	20·32	6–4	Tebbutt
1893·49	206·5	20·24	8	Sellors
1893·50	206·75	20·53	4–2	Tebbutt

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* From $\Delta\alpha$ and $\Delta\delta$. † By photography.

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After carefully inspecting the foregoing list of measures, we have formed the following mean results, which are referred to the meridian of 1900·0.

Mean Measures of α Centauri, with corresponding Computed places.

Epoch.	Angle.		Distance.		No. Nights
t	δ_o	δ_c	ρ_o	ρ_c	n
	°	°	″	″	
1690·0	...	257·62	...	5·23	1
1709·5	...	24·30	...	10·07	1
1752·2	217·84	216·66	20·51	18·30	...
1822·0	209·05	211·00	28·75	21·86	...
1824·0	214·88	211·90	22·45	21·57	35 +
1826·01	212·66	212·83	22·45	21·10	...
1830·01	214·54	214·87	19·95	19·72	...
1831·0	215·49	215·42	22·56	19·29	...
1832·16	215·87	215·73	19·85	19·04	...
1833·0	216·98	216·62	18·67	18·33	7 ±
1834·33	216·87	217·50	17·83	17·63	1
1834·45	218·32	217·57	17·50	17·56	2
1835·08	218·35	217·70	17·33	17·46	2 – 1
1835·89	219·14	218·62	17·02	16·74	11 – 1
1836·61	219·82	219·17	16·76	16·30	1
1837·22	220·21	219·67	16·39	15·93	4
1840·0	222·78	222·30	14·74	14·11	...
1846·21	232·02	232·02	10·96	9·54	3
1846·80	233·93	233·47	9·56	9·08	4
1847·09	235·33	234·22	9·33	8·87	2 – 3
1847·36	234·13	234·92	9·31	8·67	3
1848·00	237·57	236·90	8·05	8·16	13 – 12
1849·63	244·15	243·02	6·23	6·93	...
1849·95	244·98	244·47	7·00	6·70	4 – 3
1850·20	244·97	245·70	6·92	6·52	14
1850·38	246·28	246·63	6·82	6·38	8
1850·41	241·65	246·77	7·78	6·36	15
1850·62	248·62	247·90	6·39	6·22	10
1850·93	250·7	249·65	5·95	5·99	10 – 9
1851·10	251·55	250·68	5·98	5·88	21 – 19
1851·44	253·33	252·85	5·95	5·65	8
1851·87	256·14	255·87	5·53	5·37	11

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Epoch.	Angle.		Distance.		No. Nights.
t	δ_o	δ_c	ρ_o	ρ_c	n
	°	°	"	"	
1851·95	258·18	256·47	5·09	5·32	17–15
1852·33	260·58	259·43	5·24	5·09	21
1852·64	262·78	262·10	5·03	4·90	20–15
1853·27	268·73	268·07	4·69	4·57	17–18
1853·75	272·32	273·20	4·44	4·35	4–3
1854·16	277·91	278·00	4·33	4·19	13–6
1854·79	284·72	286·02	4·19	4·00	15–9
1855·25	291·26	292·28	4·29	3·91	32–17
1856·13	302·97	304·70	3·94	3·87	42–31
1856·51	309·84	310·05	3·93	3·91	10–9
1856·94	312·11	315·93	4·07	3·98	41–19
1857·27	319·09	320·27	4·24	4·07	17–16
1857·86	326·18	327·50	4·14	4·27	14
1858·17	330·22	330·99	4·39	4·41	5
1859·33	340·6	342·10	5·12	4·99	23–20
1859·52	341·52	343·80	4·92	5·11	4
1859·97	345·8	347·27	5·00	5·39	3
1860·27	347·78	349·40	5·62	5·58	26–15
1861·07	352·09	354·38	6·08	6·10	13–12
1861·44	353·38	356·50	6·26	6·36	12–10
1862·41	359·47	0·05	7·17	7·02	10
1863·03	1·14	3·57	7·2	7·44	6–4
1863·75	4·95	5·15	8·5	7·92	...
1864·11	5·55	6·33	7·85	8·16	7–5
1864·72	...	8·20	8·1	8·54	3 ±
1865·56	17·06	11·50	9·95	9·12	1
1866·06	10·86	12·75	9·3	9·32	3
1868·38	13·37	17·85	10·29	10·28	2
1868·51	21·58	18·10	11·02	10·31	5
1869·13	17·75	19·33	10·4	10·42	2
1870·1	20·24	21·20	10·24	10·47	13–12
1870·61	21·59	22·20	10·09	10·41	5–4
1870·65	24·5	22·28	10·32	10·40	3–5 ±
1870·75	22·33	22·66	10·46	10·35	4
1871·18	23·15	23·33	9·84	10·26	18
1871·49	23·35	24·15	9·82	10·10	3
1872·51	24·51	26·20	10·04	9·53	3

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Epoch.	Angle.		Distance.		No. Nights.
t	δ_o	δ_c	ρ_o	ρ	n
	°	°	"	"	
1873·25	27·91	28·05	8·90	8·86	1 – 3 ±
1874·31	30·07	31·38	7·98	7·55	3 – 4 ±
1875·02	34·04	34·45	6·82	6·46	...
1875·94	39·13	40·68	6·68	4·83	1
1876·41	46·80	45·93	4·35	3·94	2
1876·61	50·89	48·97	4·15	3·56	2
1876·92	57·09	55·17	4·72	2·98	2
1877·14	64·4	61·23	3·30	2·59	...
1877·25	68·94	64·99	3·13	2·41	5
1877·52	72·61	76·85	2·60	2·01	2 – 1
1877·56	77·09	79·00	2·11	1·96	3
1877·57	80·34	79·58	2·13	1·95	2 – 3
1877·59	81·58	80·70	1·90	1·92	3
1877·63	81·33	83·06	1·94	1·88	3 – 1
1877·82	96·97	95·43	1·85	1·71	2 – 3
1877·89	100·97	100·93	1·62	1·67	2
1878·16	116·83	122·15	1·77	1·65	1
1878·22	119·67	126·78	1·95	1·68	3
1878·28	127·12	131·17	1·77	1·72	1
1878·38	138·95	138·05	2·40	1·80	...
1879·25	174·25	172·72	3·41	3·14	...
1879·47	173·41	176·90	3·41	3·56	2
1880·18	183·76	185·47	5·22	4·95	4
1880·39	185·06	187·15	5·56	5·36	3
1880·46	184·84	187·43	5·52	5·43	1
1881·28	189·75	192·13	5·07	7·06	1
1881·54	190·00	193·18	7·52	7·54	1
1881·65	193·02	193·58	7·94	7·75	2
1882·00	194·44	194·72	8·23	8·38	18
1882·22	194·48	195·35	8·70	8·77	1
1882·50	195·82	196·08	9·12	9·25	52
1884·19	198·89	199·32	11·96	11·93	...
1884·43	199·39	199·66	12·32	12·27	...
1884·53	199·69	199·75	12·93	12·36	6
1885·56	200·7	201·08	14·05	13·80	4 – 3
1886·27	202·4	201·83	14·89	14·67	5
1886·38	200·3	202·08	14·74	14·80	1

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Epoch.	Angle.		Distance.		No. Nights.
t	δ_o	δ_c	ρ_o	ρ_c	n
	°	°	″	″	
1886·54	201·46	202·13	15·06	14·98	15
1886·59	201·46	202·87	15·17	15·04	7
1887·41	202·1	203·10	15·95	15·93	9–10
1887·69	202·31	203·57	16·07	16·22	9–8
1888·30	203·32	203·80	16·87	16·82	3
1888·63	202·85	204·38	17·12	17·12	1
1889·45	204·43	205·03	17·91	17·83	3
1890·49	204·93	205·20	18·77	18·63	9–7
1890·74	204·53	205·63	18·69	18·80	1–3
1891·50	206·01	206·03	19·25	19·31	14
1892·30	206·45	206·13	19·52	19·73	2
1892·40	205·40	206·15	19·73	19·79	5–4
1892·45	205·53	206·17	19·75	19·82	7–4
1892·58	205·83	206·23	19·73	19·86	8–5
1892·76	205·9	206·33	19·96	19·93	1
1893·21	206·9	206·53	20·04	20·03	1
1893·21	206·75	206·53	20·22	20·03	2–1
1893·34	206·4	206·56	19·92	20·18	8
1893·42	206·73	206·57	20·32	20·25	6–4
1893·49	206·5	206·65	20·24	20·34	8
1893·50	206·75	206·68	20·53	20·35	4–2

Ephemeris of α Centauri.

t	δ	ρ	t	δ	ρ
	°	″		°	″
1894·50	207·22	20·81	1903·50	211·30	21·79
1895·50	207·70	21·16	1904·50	211·73	21·64
1896·50	208·17	21·44	1905·50	212·20	21·44
1897·50	208·62	21·66	1906·50	212·65	21·20
1898·50	209·07	21·82	1907·50	213·13	20·93
1899·50	209·52	21·92	1908·50	213·62	20·62
1900·50	209·98	21·96	1909·50	214·13	20·26
1901·50	210·40	21·95	1910·50	214·67	19·88
1902·50	210·83	21·89			

From these mean results the orbit will now be deduced. The observations are accurately platted on large drawing paper by means of a protractor, and we thus obtain a series of points through which the ellipse must pass as a sort of interpolating curve. Errors of observation of course prevent the points from

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falling exactly on the arc of any true ellipse, and all that can be done is to pass the ellipse through the points so as to conform to the best observations. If the ellipse is judiciously drawn, we shall thereby eliminate not only accidental errors (as in the method of Least Squares), but also to a considerable extent free the measures from systematic errors, which are in general so troublesome in the adjustment of observations, and for the elimination of which the method of Least Squares is of no avail. By inspecting the apparent orbit, we see that the ellipse (which has been drawn with the greatest possible accuracy) satisfies the observations as a whole remarkably well; and in the deviations of the observations from the ellipse, we see the visible effects of systematic errors. The systematic errors of distance are conspicuous between 1822 and 1835; 1863 and 1870, where Ellery's distances are evidently too large; and 1875 and 1880, where the distances are generally over-estimated. There are analogous systematic errors in the position angles at different points of the orbit, but these can best be seen by inspecting the table of computed and observed places. The accompanying ellipse represents the observations as satisfactorily as could be desired, and therefore we do not hesitate to affirm that the elements deduced from this apparent orbit will be as good as can be obtained at the present time.* The elements here adopted have been determined directly from the apparent orbit by the method of Klinkerfues. In the present state of double-star astronomy, it is superfluous to attempt corrections of a very minute character, because the range of uncertainty is always considerable and there is no means of determining the true orbit with absolute rigour, since all the observations are necessarily more or less erroneous.

The following are the

Elements of a Centauri.

$P = 81{\cdot}07$ years
$T = 1875{\cdot}62$
$e = 0{\cdot}52$
$☊ = 25^\circ{\cdot}45$ (1900·0)
$i = 79^\circ{\cdot}74$
$\lambda = 51^\circ{\cdot}56$
$a = 17''{\cdot}705$
$n = +4^\circ{\cdot}44184$

Apparent orbit:

Length of major axis $= 32''{\cdot}50$
Length of minor axis $= 6''{\cdot}16$
Angle of major axis $= 27^\circ{\cdot}2$
Angle of Periastron $= 38^\circ{\cdot}0$
Distance of star from centre $= 5''{\cdot}94$

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* The reader is referred to a paper in *Astronomy and Astro-Physics* for 1893 December, in which the writer shows that in general a Least-Square

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If we adopt the parallax of Gill and Elkin (0″·75), we find that the major axis of the orbit of *α Centauri* is 23·592 astronomical units; from which it follows that the combined mass of the components is 1·998 times the mass of the Sun and Earth, or sensibly twice the mass of the Sun. Thus we see that the companion of *α Centauri* moves in an orbit with a major axis which is about a mean between those of the planets *Uranus* and *Neptune*; but the orbit is so eccentric that in *Periastron* the two stars are only slightly remoter than the Sun and *Saturn* (11·3), while in *Apastron* the distance considerably surpasses that of *Neptune* from the Sun (36·0).

According to the preliminary reseaches * of Stone the masses of the two components of *α Centauri* are approximately equal. As it would be a matter of great scientific interest to determine this mass-ratio by means of more recent data, it had been the intention of the writer to embody the results of such a research in the present paper, but as new measures of the positions of the components are now being made at the Cape of Good Hope, it will be advisable to reserve the investigation of the centre of gravity for some future occasion. The great cosmogonic interest attaching to binary systems ought to induce astronomers to determine wherever possible the mass-ratio of the components, as the results will throw important light upon the problem of the formation and development of double stars. If the relative masses and the eccentricity can be determined with the desired degree of precision, the data thus obtained will not only be useful in fundamental astronomy, but will also furnish a firm foundation for future research in stellar cosmogony.

In conclusion, the writer desires to acknowledge his special obligations to Mr. J. W. Froley, M.Sc., Fellow in Astronomy at the University of Chicago, for valuable assistance in the calculations embodied in this paper; also to thank Mr. S. W. Burnham for generous advice and assistance in collecting the long list of observations.

The University of Chicago:
1893 *August* 1.

Note.

Since the foregoing paper was finished, an important article on the orbit of *α Centauri*, by Mr. A. W. Roberts, has appeared in the *Astronomische Nachrichten*, No. 3,175. The results are almost identical with those obtained here, but as the two sets

adjustment is impracticable (owing to the absence of condition underlying the theory of Least Squares), and that it is also inadvisable to employ graphical interpolating curves to correct the angles or distances. The course here adopted is there fully discussed and justified.

* *Monthly Notices*. 1875–6, p. 259.

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of elements are independent of each other and were obtained by very different methods, the coincidence can only indicate that the elements found are very near the truth. We may confidently believe that the orbit of *α Centauri* is now as well known as that of any binary star in the heavens. If in the course of time any corrections shall be required for the elements given above, it is certain that the changes will of necessity be very small.

The University of Chicago :
1893 *August* 30.

The Periodic Variation in the Motion of 61 *Cygni.*
By Harold Jacoby, B.A.

The important discovery by Dr. Wilsing [*] of a periodic variation in the distance of the components of 61 *Cygni* is of so great interest that it would seem desirable to re-examine the Oxford measures, to see whether additional evidence can be found. The late Professor Pritchard did not measure the distance between the two components directly, as was done at Potsdam. But in his parallax determination he employed two comparison stars (*a* and *b*), which lie very nearly on the great circle joining the two components of 61 *Cygni*. As the distance from each of these comparison stars to such component was always independently measured, we have but to perform a subtraction to get what is very nearly the distance between the two components. In fact, Professor Pritchard himself computed such "differences" for another purpose, and they are printed in his *fasciculus* iii., p. 24, for star *a*, and p. 37 for star *b*. They ought to exhibit a variation similar to that found by Dr. Wilsing from the Potsdam plates. In examining whether such is the case, I have thought it best to treat the results from stars *a* and *b* independently. Professor Pritchard gives also the excess of the mean of all the "differences" over each individual one. I have united these into general means; and to avoid any bias in selecting the several groups for this purpose, I have taken each calendar month by itself, except that the plates of 1886 May 26, 28, 30, and July 1, were included in the group for 1886 June. These were the only plates made in those two months, and their number was too small to use them separately. It is evident that the numbers so obtained will be positive when the distance of the components of 61 *Cygni* is small, and negative when it is large, as compared with its mean value. In this way I find the fol-

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[*] *Kgl. Akad. d. Wissensch. zu Berlin, Sitzungsb.*, xl., p. 879, 1893 Oct. 26.